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Avian Acoustic Monitoring Study at the Maple Ridge Wind Project 2007-2008

Final Report

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AVIAN ACOUSTIC MONITORING STUDY AT THE MAPLE RIDGE WIND PROJECT 2007-2008

Final Report

Prepared for the

NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY

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NOTICE

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1.0 SUMMARY

A study of avian nocturnal flight calls was carried out at the Maple Ridge Wind Project (MRWP) in the spring and fall migration periods of 2007 and 2008. The purpose of the study was to investigate the potential of such monitoring to forecast avian fatalities at proposed and existing commercial-scale wind energy projects. Avian night flight calls were recorded from a single location within the MRWP with a microphone and a PC computer. Flight calls were automatically extracted from the recordings using specially designed software, then manually analyzed for species information with a focus on easily classifiable warbler and sparrow calls.

This acoustic study detected flight calls of 16 avian species that were not documented by previous avian risk assessment studies at MRWP, including two species that are listed as threatened in New York – the Least Bittern and Upland Sandpiper. In the fall migration period of 2008, the audio record was suitable for consistently gauging variations in the nightly flight call activity of warblers and sparrows during the season. A total of over 20,000 warbler and sparrow nocturnal flight calls were documented between August 1 and October 17, 2008. However, no sparrows and just two warblers were found during this period in a contemporaneous fatality survey at the wind project. Therefore, no evaluation of the relationship between acoustic activity and avian fatalities could be performed.

Besides the acoustic data gathered at the Maple Ridge Wind Project, this report includes contemporaneous avian flight call data collected from a transect of four stations 50-65 km to the northwest of MRWP and a single station operating 230 km to the southwest. Acoustic data is compared between these sites as well as from MRWP and it is theorized that the different species patterns between sites may be reflected in the wind energy fatalities for each region.

2.0 INTRODUCTION

Evaluation of the existing data from flying animal mortality studies at wind energy projects in eastern North America indicates that various species of night migrating birds typically make up a large proportion of the avian fatalities. In order to address this issue, and perhaps minimize wind energy's impact on these species, preconstruction methodologies for studying avian nocturnal migration have been employed. The most prevalent study method has been radar. To a lesser extent, night vision and acoustic monitoring have been used. However, after more than ten years of using these methodologies, there is little evidence compiled showing these methods have use for understanding and mitigating mortality. In 2007, the New York State Energy Research & Development Authority (NYSERDA) undertook a research initiative attempting to validate the utility of the prominent methodologies for assessing impacts to nocturnal migrant birds and bats. The study occurred at the Maple Ridge Wind Project (MRWP) near the village of Loweville in Lewis County, New York. This report presents data and discussion on an avian acoustic monitoring study that was part of the larger NYSERDA nocturnal migration study at the project site.

3.0 BACKGROUND

Most species of North American migratory landbirds are known to migrate at night, and many of these species give short vocalizations while they fly (Evans and O'Brien 2002). The calling is thought to help birds maintain in-flight associations (Hamilton 1962) and help organize their spacing to minimize the chances of mid-air collisions (Graber 1968). The calls may also serve for echolocation, giving night migrating birds a reference for their altitude above ground.

Studies carried out from the late 1980s to mid-1990s indicated what had been generally known to field ornithologists, that monitoring avian flight calls at night could reveal unique information about the species activity of vocal birds passing over in nocturnal migration.[1] The first study applying such acoustic monitoring at a wind project in North America was carried out by W. Evans at a proposed Nebraska Public Power District (NPPD) wind energy project near Ainsworth, NE in fall 1996 and spring 1997.[2] A goal of this study was to gain some sense of the abundance of Baird's Sparrow, a species thought to be in population decline, as it passed through the NPPD project. While nothing conclusive about Baird's Sparrow resulted from the study, unique information was gained regarding other species of potential avian collision risk. Also noteworthy were the relatively low numbers of flight calls detected and the few nights of steady avian nocturnal flight call activity compared to eastern North America acoustic study sites. The 60 MW project did not become operational until 2005. A post-construction fatality study by West Inc. (not publically available) reportedly "indicated one of the lowest avian mortality rates for a wind-powered generation facility in the United States."[3]

The Nebraska study, as well as a research study on the effectiveness of microphone arrays for determining the flight height of birds via their calls, was the center of a paper titled *Applications of Acoustic Bird Monitoring for the Wind Power Industry*. The paper was presented by W. Evans at a meeting of the Avian Subcommittee of the National Wind Coordinating Committee (NWCC) in San Diego in 1998 and later published in the NWCC proceedings from the meeting.[4]

In 1999 and 2000, W. Evans carried out an acoustic study of avian night migration concurrently with a fatality study at two adjacent wind projects in northeastern Wisconsin.[5] Only four of the 25 total avian carcasses found over the two-year fatality study were night migrating birds known to give regular flight calls in migration. Therefore, no correlation of fatality and acoustic data could be made. The acoustic data did provide unique data on the species potentially at risk of collision. Altitudinal flight data from the

[1] Evans and Mellinger 1999; Evans and Rosenberg 2000.
[2] Evans 1997.
[3] http://www.nppd.com/about-us/power-plants-facilities/wind-generation/general-information/ (accessed October 16, 2012)
[4] Evans W.R. 2000.
[5] Howe et al., 2002.

acoustic study also yielded information about the proportion of vocal birds flying below turbine height and the variability and consistency of flight altitudes from one night to the next.

Avian acoustic monitoring was listed as one of the recommended preconstruction survey methods in the 2003 United States Fish and Wildlife Service (USFWS) Guidance for wind developers.[6] From 2003 through 2006, Old Bird Inc. conducted preconstruction acoustic studies of avian night migration for wind developers in western Maryland, northern West Virginia, west-central New York, north-central Pennsylvania, and east-central Vermont.[7] Most occurred for at least one migration cycle and all involved comparing data from multiple acoustic stations in their regions. Two of the studies were coordinated with concurrent radar studies (New York & Maryland). The acoustic studies provided unique species information as well as migration timing and altitude information. All five studies also suggested massive channeling of low-altitude (<300 m agl) migration caused by montane geography on nights with a low cloud ceiling. This was indicated by great differences in the flight call activity between stations at different altitudes (>50 m difference) that were only a few kilometers from one another. Typically the higher station was shrouded in cloud, which is apparently an atmospheric condition less desirable for avian nocturnal flight.

Kunz et al. (2007) presented perhaps the most recent detailed discussion of the various migration monitoring methodologies for wind projects. Their report however, needs clarification regarding bat and bird acoustic monitoring. The opening sentence in the section on Acoustic Monitoring of Nocturnal Migrating Songbirds (p. 2479) begins with two sentences noting perceived problems with the technique:

> "Recording calls of birds that migrate at night permits identification of many species and similar-sounding groups of species by experienced listeners, but this method does not give a direct indication of numbers or rates of passage. Because the rate of calling varies greatly from night to night, extended sampling periods are needed…." P. 2479 Kunz et al. 2007

The acoustic monitoring for the bat section (p. 2479) begins with an upbeat sentence:

> "Acoustic detection of bats provides an effective method for assessing bat presence and activity." P. 2479 Kunz et al. 2007

In fact, the latter statement for bats is also true for birds and the problems noted previously in Kunz et al. 2007 for acoustic monitoring of songbirds also apply to bats. Acoustic monitoring of flying animal vocalizations does not give a direct indication of numbers passing; it provides an index for activity, which when variables are considered may be an index to numbers passing (e.g., Larkin et al. 2002). Additionally, acoustic monitoring provides no information about animals that do not vocalize during migration and often extended sampling periods are necessary to reasonably document migration activity.

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[6] http://www.fws.gov/habitatconservation/Service%20Interim%20Guidelines.pdf (accessed September 2, 2012)

[7] Evans W. R. 2005a (New York), 2005b (Pennsylvania), 2006 (Vermont). The reports for the studies from Maryland and West Virginia are currently in preparation after having been delayed from release due to legal constrictions.

While acoustic monitoring for birds was brought to the attention of wind developers and wildlife regulators well before the bat impact issue arose (Evans 2000), bats rightly received a great deal of focus and monitoring initiatives after their fatalities at wind energy projects began to gain attention in 2002.[8] The proliferation of bat versus slower growth of bird acoustic monitoring at wind projects can be attributed to three situations. The first, involves the larger number of bat fatalities that have been documented. Second, relatively little is known about bat distributions, populations, and their movements. Third, bat acoustic monitoring technology was well-established when the issue was gaining momentum around 2005. In contrast, relatively small numbers of night migrating birds have been documented as fatalities at wind projects. Bird distributions, populations, and movements are much better known than bats due to various diurnal observation methods. The methodology for acoustic monitoring of avian nocturnal movements has only recently become commercially available and utilized (e.g., Old Bird Inc; Wildlife Acoustics).
Avian acoustic monitoring remains one of the recommended preconstruction survey methods in the 2011 USFWS Guidance for wind developers.[9] Between 2008 and 2012, there were at least ten consulting firms carrying out avian acoustic monitoring studies at wind energy projects in North America.

There is no doubt that acoustic monitoring can augment a wind project's diurnal bird studies by detecting additional species flying through a wind project at night.[10] It is also true that avian acoustic monitoring can reflect relative activity levels for vocal species within and in proximity to a wind project site, as well as distant regions.[11] This study was the first attempt to evaluate how the quantity of vocal activity from night migrating birds relates to actual fatalities. However, the scope was limited to the analysis of data from one acoustic station in the MRWP for a substantial portion of the 2007 & 2008 migration periods.

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[8] Howe et al. 2002.

[9] http://www.fws.gov/windenergy/docs/WEG_final.pdf (accessed September 2, 2012)
[10] Evans 2005; Evans 2008.
[11] Evans & Mellinger 1999; Evans & Rosenberg 2000.

4.0 METHODS

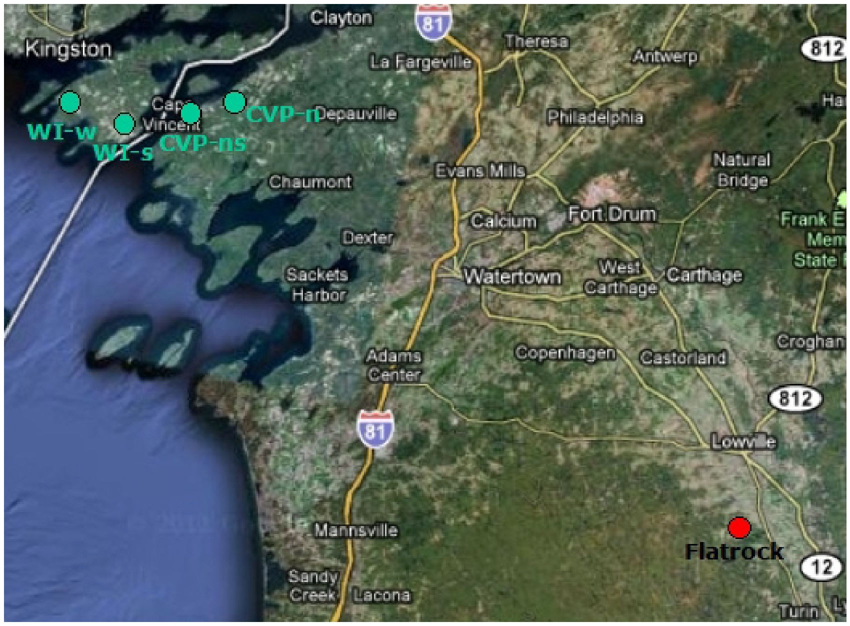
This study aimed to analyze a record of avian nocturnal flight calls collected from one acoustic monitoring station within the MRWP that operated during the spring and fall migration periods of 2007 and 2008. In order to reduce the chances of missing nights of data due to equipment malfunction, a second acoustic station was operated in the vicinity of the first. To reduce labor costs associated with the operation of these stations, they were programmed to record sound automatically. To provide a regional perspective to the MRWP avian acoustic activity data, concurrent avian acoustic data was evaluated from similar acoustic monitoring stations operating in an array spanning the Cape Vincent Peninsula, New York and Wolfe Island, Ontario. These stations ranged from 53-64 km northwest of the MRWP and are referred to in this report as the “array” stations. In addition, acoustic data from a similar monitoring station at Alfred, New York, approximately 230 km southwest of MRWP, was included for comparison. Figure 1 shows the geographic relationship of these different acoustic monitoring regions. Figure 2 shows the location of the individual array acoustic monitoring stations in respect to the location of the principle acoustic monitoring site at the MRWP, referred to in this report as the “Flatrock” acoustic station.

Each acoustic monitoring station consisted of an Old Bird “flowerpot” type microphone, an audio preamplifier, and a PC computer.[12] The PC was programmed to automatically record 16 bit, 22,050 sampling rate, audio files (wav format) from sunset to sunrise each evening during the migration periods. The spring migration study targeted the peak migration period from late April through mid-June. The fall migration study targeted the peak migration period from August through mid-November. Figure 3 shows the avian acoustic station locations within MRWP. Figures 4a-d show photos of four of the acoustic monitoring sites involved in this study.

[12] The electronic circuit and “flowerpot” housing are shown at http://www.oldbird.org/mike_home.htm. A small pyramid reflector was substituted for the plate to provide more gain. Wav recordings were made with a PC running Windows XP.

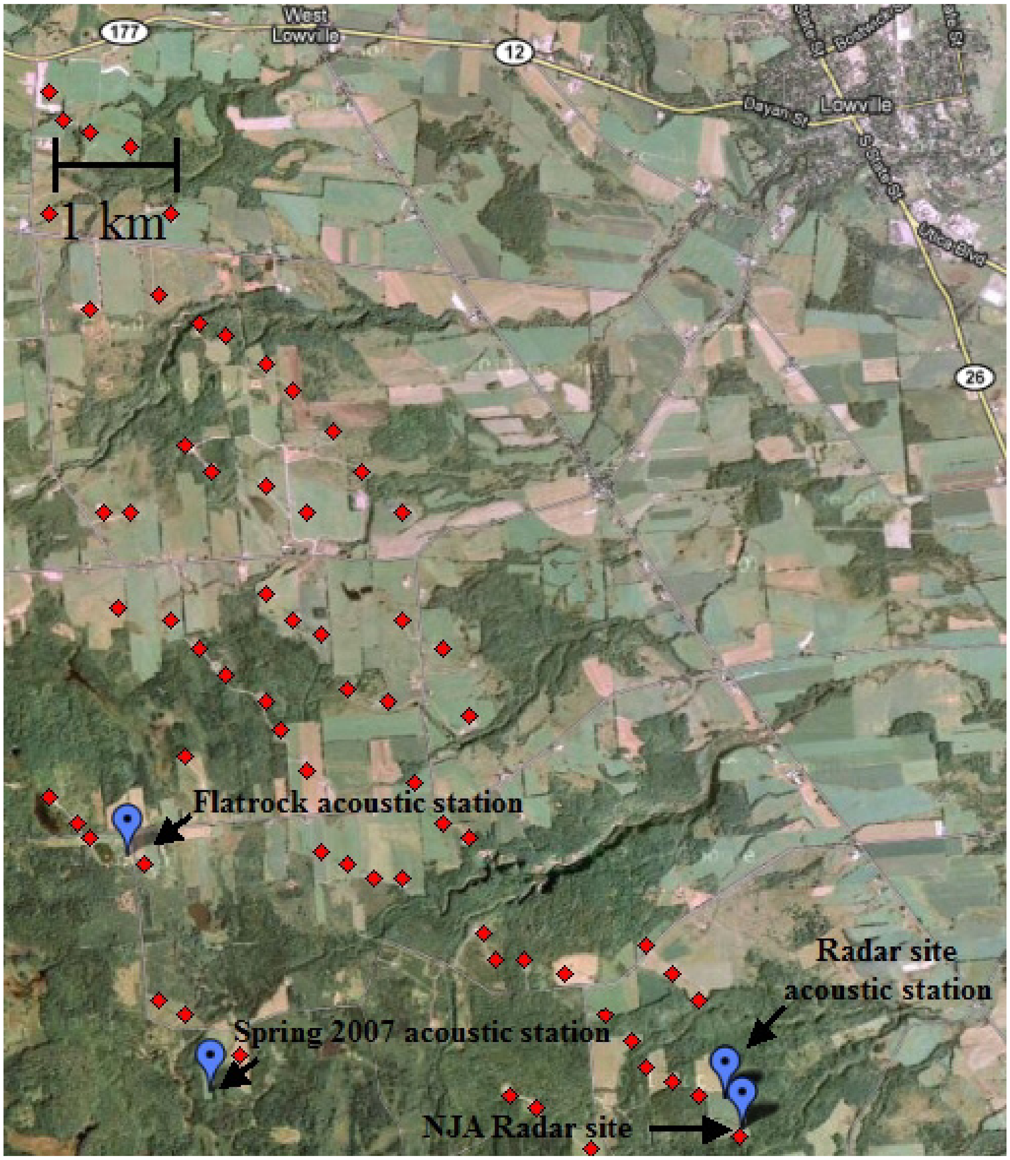
CNES/Spot image, DigiGlobe, Geoeye, NYS GIS,
USDA Farm Services Agency, Map Data © 2011 Google Imager.

Figure 1. Regional acoustic monitoring sites discussed in this report. The light blue circle is the acoustic monitoring site near Alfred, New York. The red circle is the location of the "Flatrock" acoustic monitoring station within the MRWP that operated in fall 2007 and 2008. The pink oval is the location of four acoustic stations (the "array" stations), one or more of which operated in spring and fall of 2007 & 2008.



CNES/Spot image, DigiGlobe, Geoeye, NYS GIS,
USDA Farm Services Agency, Map Data © 2011 Google Imager.

Figure 2. The red circle is the location of the "Flatrock" acoustic monitoring station at MRWP that operated in fall 2007 and fall 2008. The green circles show the location of the array of acoustic monitoring stations that operated 53-64 km northwest of the MRWP in fall 2007. The CVP-n station also operated in spring and fall 2008.



CNES/Spot image, DigiGlobe, Geoeye, NYS GIS,
USDA Farm Services Agency, Map Data © 2011 Google Imager.

Figure 3. Blue markers indicate locations of avian acoustic monitoring stations and the New Jersey Audubon Society (NJAS) radar study site near the southern end of the MRWP. Red markers are MRWP wind turbine locations.

Figure 4a. “Radar” acoustic station. Skyward-facing microphone is in gray cylinder. Recording gear and batteries are under plastic tarp. The white New Jersey Audubon radar trailer can be seen just to the right of the base of the wind turbine. Lat 43.714767, Long -75.505257

Figure 4b. “Flatrock” acoustic station. Skyward-facing microphone is in gray cylinder. Recording gear is in adjacent building. Lat 43.732623, Long -75.56581

Figure 4c. “Spring 2007” acoustic station. Microphone is tan “flowerpot” container on left. Recording gear and batteries are under tarp. Lat 43.715287, Long -75.557485

Figure 4d. “CVP-n” acoustic station on the Cape Vincent Peninsula in northern New York. Skyward-facing microphone is in gray cylinder. Lat 44.143564, Long -76.206056

Analysis of data was carried out using the software Tseep-x and Thrush-x developed by Old Bird. These processes were used to extract avian flight calls from the all-night audio recordings. The software detects vocalizations of most species of migrant birds passing through New York.[13] This includes all small passerines known to vocalize at night in eastern North America. The software triggers detection of a potential bird call when a short sound reaches a certain amplitude level above the existing background noise. Old Bird's spectrograph viewing software, GlassOFire, was used to classify the detected calls into species categories.[14] This classification operation was a visual analysis of audio spectrograms performed by W. Evans.[15]

For the purposes of this study, only calls that could be fairly confidently placed into distinctive species categories were classified.[16] Unknowns or species that could only be placed into a complex of similar species were assigned the category of "No ID". These unidentified calls were utilized for gauging nightly migration activity and for determining the ratio of identified species' calls to the total calls documented in a night. Such data along with ratios of one species' calling to another's helps facilitate comparison of species activity between acoustic study sites because equipment and ambient noise variables between study sites tend to drop out. In this study similar monitoring equipment was used at each acoustic station, so equipment variables were not an issue but environmental noise varied between sites. The automatic call detection software detects potential calls when they are louder than existing background noise. Therefore, the raw call totals detected at a station are influenced by the level of ambient noise in the frequency band being surveyed. In other words, a station that has twice the number of calls as another over the same study period could simply be due to the level of environmental noise at one particular station. Since this study primarily involved analysis of data from one acoustic station, an important consideration was to site the station in as quiet a location as possible in order to optimize sensitivity for flight call pickup.

While data from the whole night (sunset to sunrise) was analyzed for calls of unique species, data from within the first hour after sunset and the hour before sunrise were not consistently evaluated for quantitative calling data. These periods contain vocalizations of non-migrant birds (e.g. dawn chorus in spring) and such calling may impede detection of migrant birds and bias consistent sampling. In addition, some species such as *Catharus* Thrushes have well-documented prolific calling behavior while descending from nocturnal migration within the two-hour period before sunrise. Savannah Sparrow, Ovenbird and other small passerines also frequently have distinctly different flight calling behavior in this pre-sunrise period.

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[13] Details on the analysis software can be found at this link: http://www.oldbird.org/analysis.htm
[14] Ibid.
[15] GlassOFire settings used – FFT: 512, Frame length: 128, Window function: Hamming, Hope size: 10. Minimum spectrogram size of 4.5 cm x 5.75 cm @ ~45 cm viewing distance.
[16] Known issues with the species classification data in this report: 1) Savannah Sparrow calling data are likely contaminated with a relatively small number of Sharp-tailed Sparrow calls. 2) Parula Warbler calling data are likely contaminated with a relatively small number of Pine Warbler calls. Ovenbird has a highly variable call and it is likely that a substantial number of its calls were missed. Some variations of Mourning Warbler and Yellow-rumped Warbler may have been misclassified as Ovenbird. Some variations of Northern Waterthrush were likely missed and lumped in the "zeep" category.

One cannot compare rates of avian flight calling unless the same behavioral contexts are evaluated. Therefore, nightly flight call activity levels of species in this study were characterized using a substantial portion of the mid-section of night when the bulk of birds were generally aloft and cruising in migration rather than in takeoff or descent mode. For the fall migration species data presented in this study, a nine-hour period from 8:30 p.m. to 5:30 a.m. was evaluated.

5.0 RESULTS

There were substantial challenges with the acoustic recording sites in the MRWP study. Although it operated successfully, the acoustic station closest to the radar station ("radar" acoustic station in Figures 3 & 4a) turned out to have many nights compromised by noise from a nearby wind turbine. One of the blades on this wind turbine made a regular loud whistle sound on nights with certain wind conditions. The audio frequency of the whistle was in the same band as many warbler and sparrow flight calls and impeded consistent detection of these calls by the automated flight call extraction software. This problem didn't become fully apparent until after the first year of data was assessed. Therefore in spring 2007, data from the backup acoustic station was used to gauge nightly migration activity. Unfortunately, in fall 2007 and spring 2008 both the primary and the backup acoustic stations had audio interference problems that compromised using the data as a gauge of nightly migration activity. The primary station had interference from wind turbine noise and the backup station had intermittent audio interference emanating from the AC electrical system at the residential power source. This interference compromised consistent analysis of the full audio spectrum for bird calls on many nights.

The compromised data sets were successfully analyzed for unique species composition; but, they were unable to provide a consistent gauge for the level of migration activity based on calling rates. Acoustic data from this study that did enable consistent analysis of flight call rates through the migration season were gathered from the "spring 2007" station (Figures 3 & 4a) in spring 2007 and the "Flatrock" station (Figures 3 & 4c) in fall 2008.

Table 1 shows a list of species from the MRWP acoustic stations that were not detected in any of the wind project's pre- and post-construction avian surveys.

Table 1. Species detected in the MRWP avian acoustic monitoring study that were not detected in the pre-or post-construction avian studies at MRWP.

Species	Spring 2007	Fall 2007	Spring 2008	Fall 2008
Least Bittern	no	yes	no	yes
Black-crowned Night-Heron	no	yes	no	yes
Virginia Rail	yes	yes	yes	yes
Spotted Sandpiper	yes	yes	yes	yes
Upland Sandpiper	no	yes	no	yes
American Pipit	no	yes	no	yes
Gray-cheeked Thrush	yes; May-early June	yes; regular mid Sep-mid Oct	yes; May-early June	yes; regular mid Sep-mid Oct
Bay-breasted Warbler	no	fairly common; late Aug-mid Sep	yes; May	fairly common; late Aug-mid Sep
Cape May Warbler	yes; May	fairly common; late Aug-mid Sep	yes; May	fairly common; late Aug-mid Sep
Palm Warbler	no	fairly common; mid Sep-mid Oct	yes; May	fairly common; mid Sep-mid Oct
Parula Warbler	yes	fairly common; late Aug-mid Sep	yes; May	see Table 3
Wilson's Warbler	yes	fairly common; mid Aug-mid Sep	2 calls	see Table 3
American Tree Sparrow	no	regular; Nov	no	regular; Nov
Fox Sparrow	no	fairly common; late Oct-Nov	no	fairly common; late Oct-Nov
White-crowned Sparrow	yes; May	fairly common; late Sep-mid Oct	yes; May	fairly common; late Sep-mid Oct
Snow Bunting	no	Yes; Oct	no	Yes; Oct

5.1 Spring 2007

In the spring 2007 acoustic monitoring, viable acoustic data was gathered at the "Spring 2007" site (Figures 3 & 4a) on 40 nights from May 3 through the night of June 13. Two nights were missed due to equipment problems (May 29-30; 30-31). *Catharus* Thrushes and other mid-frequency flight calls (detected using Thrush-x) were not consistently extracted due to varying interference from frog noise (spring peepers) in a nearby wetland. As is typical of spring migration in New York, relatively few warbler and sparrow flight calls were recorded compared to fall migration. 1,205 total warbler and sparrow calls were recorded.

Species information in the calling data was extracted and unique species that were not detected in previous bird survey work at MRWP are noted in Table 1. Generally, so few calls of any one species were detected that the datasets were not sufficiently large enough to produce species ratio data or enable the possibility for correlation with fatality data. Only single individuals of two species tracked acoustically were documented in the fatality study during spring 2007.

5.2 Fall 2007

Of the two acoustic stations operating at MRWP, only a 14-day period from the night of August 24-25 through the night of September 6-7 at the Flatrock acoustic station had a consistent sound field for evaluating changes in avian flight call activity. As noted, the "radar" acoustic station had interference from a nearby wind turbine and the other portions of the fall season at the Flatrock station had intermittent electrical interference in the residential AC power supply. To augment the data for fall 2007, acoustic data from an array of four similar acoustic monitoring stations 53-64 km northwest of MRWP are included (see stations WI-w, WI-s, CVP-n, and CVP-ns in Figure 2). Figure 5 shows a comparison of warbler and sparrow flight call data from one of these array stations (CVP-n) with the Flatrock station at MRWP (14 nights when both were operating concurrently). The flight call activity of the CVP-n acoustic station showed moderate positive correlation with the Flatrock acoustic station ($r = 0.61$, $p < 0.021$). This contrasts with warbler and sparrow flight call activity between the CVP-n station and three nearby stations in the acoustic array where there was strong statistical correlation ($r = 0.90+$, $p < .001$) for an 11-day stretch when three of these array stations operated concurrently (Figure 6). A similar acoustic station operating simultaneously in Alfred, New York, 200-230 km to the southwest had surprisingly good statistical correlation between warbler and sparrow flight call activity with the array and Flatrock acoustic stations (Table 2).

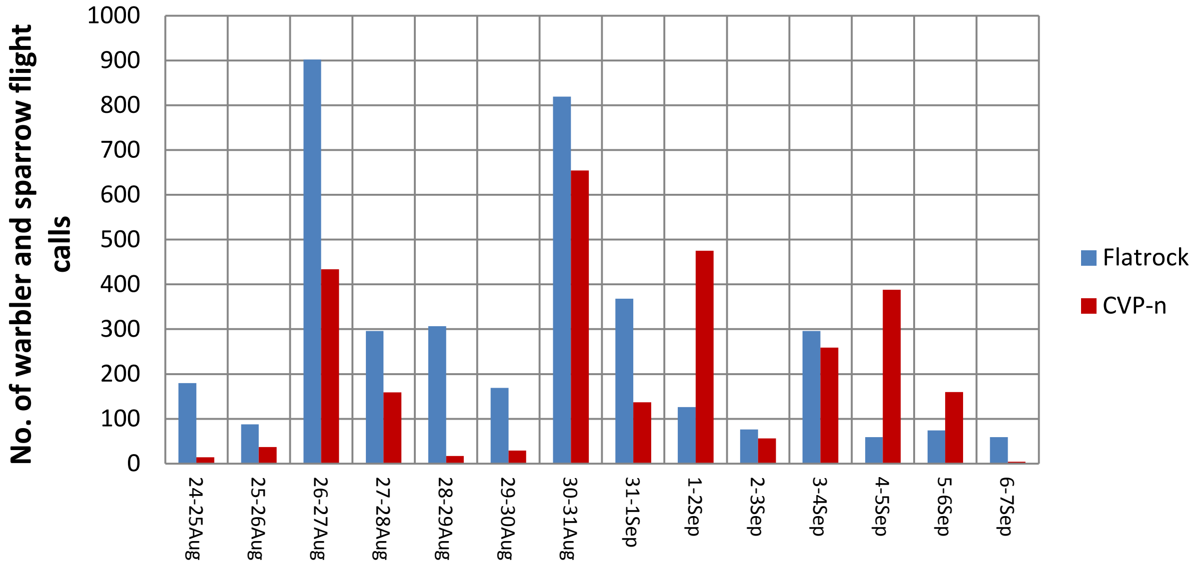

Figure 5. Comparison of nightly warbler and sparrow flight call totals (8:30 p.m. – 5:30 a.m.) between the Flatrock and CVP-n acoustic stations in fall 2007. The 14 nights shown have a moderate positive correlation ($r = 0.61$, $p = 0.02$). Blue bars are data from the Flatrock station; red bars are data from the CVP-n station.

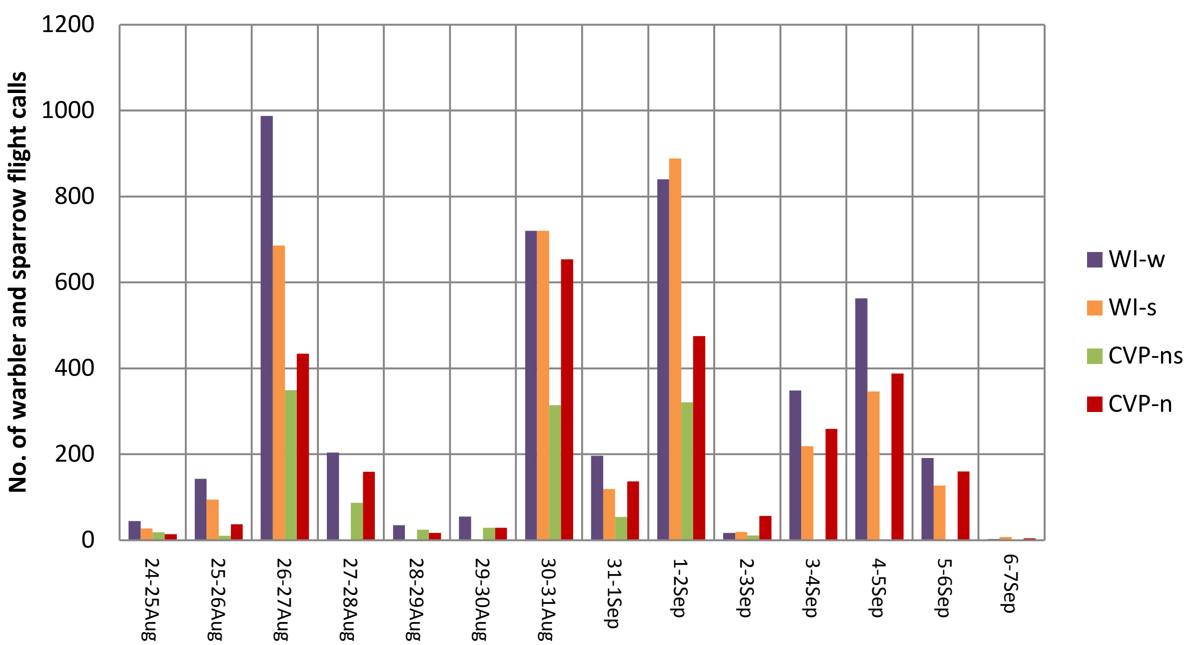

Figure 6. Comparison of nightly warbler and sparrow flight call totals between the array acoustic stations in fall 2007. Station CVP-ns did not have data after the night of September 2-3. Station WI-s is missing the three nights of August 27-29. Purple bars are data from the WI-w station; orange bars are data from the WI-s station; green bars are data from the CVP-ns station; red bars are data from the CVP-n station.

Table 2. Correlation coefficients between nightly totals of warbler and sparrow flight calls detected over 11 nights in fall 2007 at simultaneously operating acoustic stations in New York and Wolfe Island, Ontario. Red text highlights strong correlation ($p < 0.001$) between the proximal array acoustic stations.

Acoustic station pair	Pearson's r
Flatrock & CVP-n	0.70, p = 0.017
Flatrock & WI-w	0.68, p = 0.02
Flatrock & CVP-ns	0.70, p = 0.016
CVP-ns & CVP-n	**0.93, p < 0.001**
CVP-n & WI-w	**0.91, p < 0.001**
WI-w & CVP-ns	**0.98, p < 0.001**
CVP-n & Alfred	0.59, p = 0.058
CVP-ns & Alfred	0.64, p = 0.035
WI-w & Alfred	0.71, p = 0.014
Flatrock & Alfred	0.79, p = 0.004

While Figure 6 and Table 2 showed strong correlation in the changes in nightly flight call activity among the array acoustic stations (CVP-n, CVP-ns, WI-w, WI-s), in some cases the species composition between stations had distinctly different patterns. For example, in Figure 7 note the difference in the percent of Common Yellowthroats between the two array stations CVP-n and CVP-ns that were only six kilometers apart. Common Yellowthroat calls made up 7.6 percent of the calling at the CVP-n station while only 2.3 percent at the WI-w station 25 km to the west.

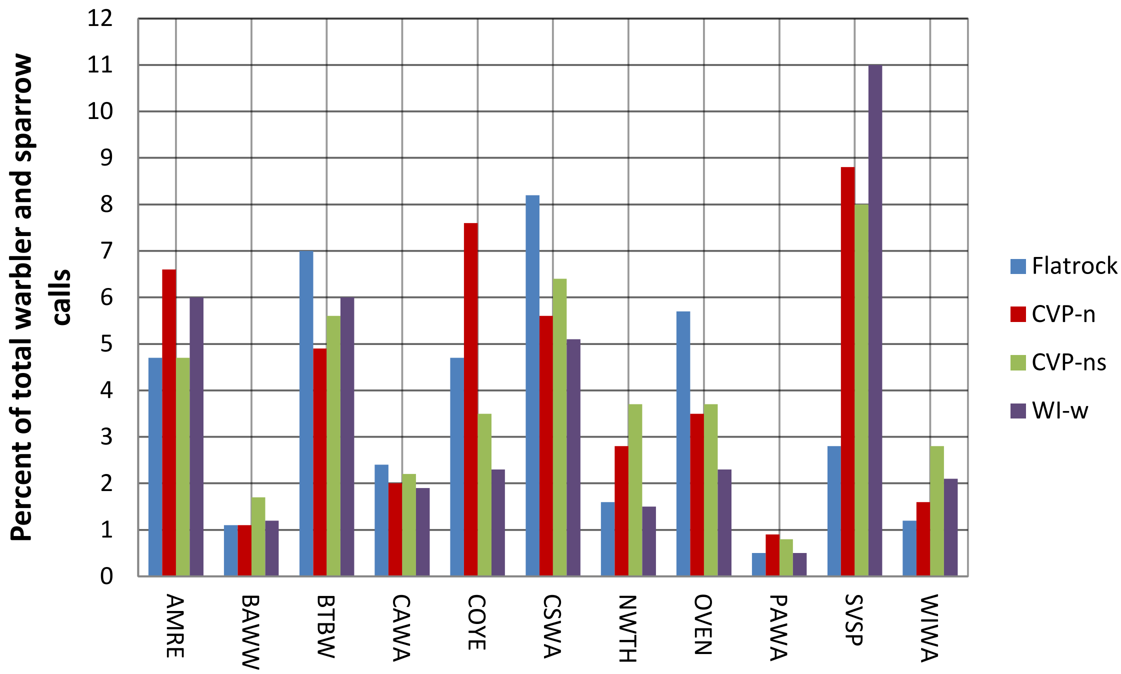

Figure 7. Proportion of calling of common night migrants over the 11-night comparative study period in fall 2007. Blue bars are data from Flatrock; red bars are data from CVP-n; green bars are data from CVP-ns; purple bars are data from WI-w. AMRE = American Redstart; BAWW = Black-and-white Warbler; BTBW = Black-throated Blue Warbler; CAWA = Canada Warbler; CSWA = Chestnut-sided Warbler; COYE = Common Yellowthroat; NWTH = Northern Waterthrush; OVEN = Ovenbird; PAWA = Parula Warbler; SVSP = Savannah Sparrow; WIWA = Wilson's Warbler.

Note also in Figure 7 that the Flatrock acoustic station had higher proportions of Ovenbird, Black-throated Blue, and Chestnut-side Warbler than the array stations. It also had a much lower percentage of Savannah Sparrow calls.

Table 3 shows comparative calling ratios of one species to another over the 11-day comparison period.[17] In some cases there are substantial variations between stations. From just looking at this ratio data it is unknown whether the variation is due to an increase or decrease in one species or the other. These ratio data however, show that there are substantial differences in the species calling proportions between the acoustic monitoring sites in this study. Notable is that the ratio of Chestnut-sided Warbler to Common

[17] This metric removes the influence of other species from ratio data.

Yellowthroat at the CVP-n acoustic site is less than half that at the CVP-ns acoustic station, which was only 6 km to the east. It was also half that of the Flatrock acoustic station 60 km to the southeast.

Table 3. Species ratios at the Flatrock and array acoustic stations. Numbers represent the total number of calls of one species divided by the total number of calls of another species over the 11-night comparative study period. See Figure 7 for 4-letter species codes.

	Flatrock	CVP-n	CVP-ns	WI-w
CSWA/COYE	1.7	0.7	1.8	1.2
AMRE/BTBW	0.7	1.4	0.9	1.0
CAWA/WIWA	2.0	1.2	0.8	0.9
BTBW/NWTH	4.5	1.7	1.9	3.9
OVEN/SVSP	2.0	0.46	0.40	0.20

The ratio of Canada Warbler to Wilson's Warbler in Table 3 is interesting in that the Flatrock station almost doubles that of the average among the array stations. Regarding the ratio of Black-throated Blue Warbler to Northern Waterthrush, the two Cape Vincent Peninsula acoustic stations are about half that of the Flatrock and WI-w station. Acoustic stations that had the highest Black-throated Blue Warbler percentage of total calling also had the lowest Northern Waterthrush percentage of total calling. The ratio of Ovenbird to Savannah Sparrow was ten times greater at Flatrock than WI-w.

5.3 Spring 2008

Intermittent audio interference at both MRWP acoustic stations affected the utility of these data for use as an indicator of avian flight call activity. Species information in the calling data was extracted and unique species not detected in previous survey work at MRWP are included in Table 1. While no record of spring 2008 avian flight calling was adequate for gauging migration activity at MRWP, such a record was documented for 37 nights at the CVP-n acoustic station, 53 km northwest of MRWP. Figure 8 shows nightly call totals for warblers & sparrows and thrush-class calls, which may reflect pulses of migration activity across the region.

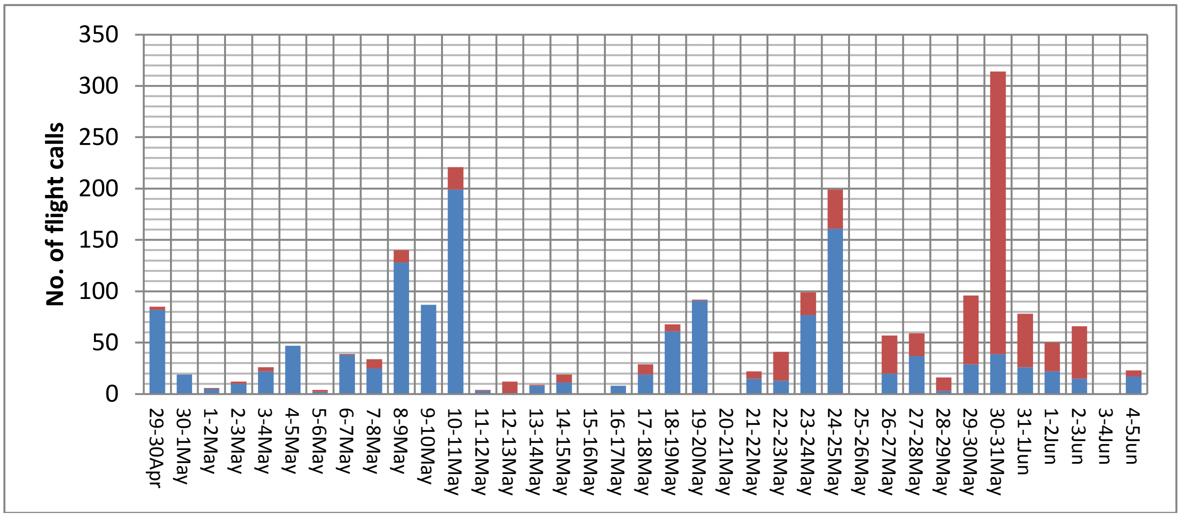

Figure 8. Nightly flight call activity at the CVP-n acoustic monitoring station, 53 km NW of MRWP, in spring 2007. Blue section of bars indicate warbler & sparrow flight call totals; red section of bars indicate thrush-type call totals.

5.4 Fall 2008

The Flatrock acoustic station had the best record of the two acoustic stations operating at MRWP this season. This station had a complete nightly record from the evening of July 31 through October 17.[18] Over 21,000 warbler and sparrow flight calls and more than 4500 thrush-type calls were documented (Figure 9).

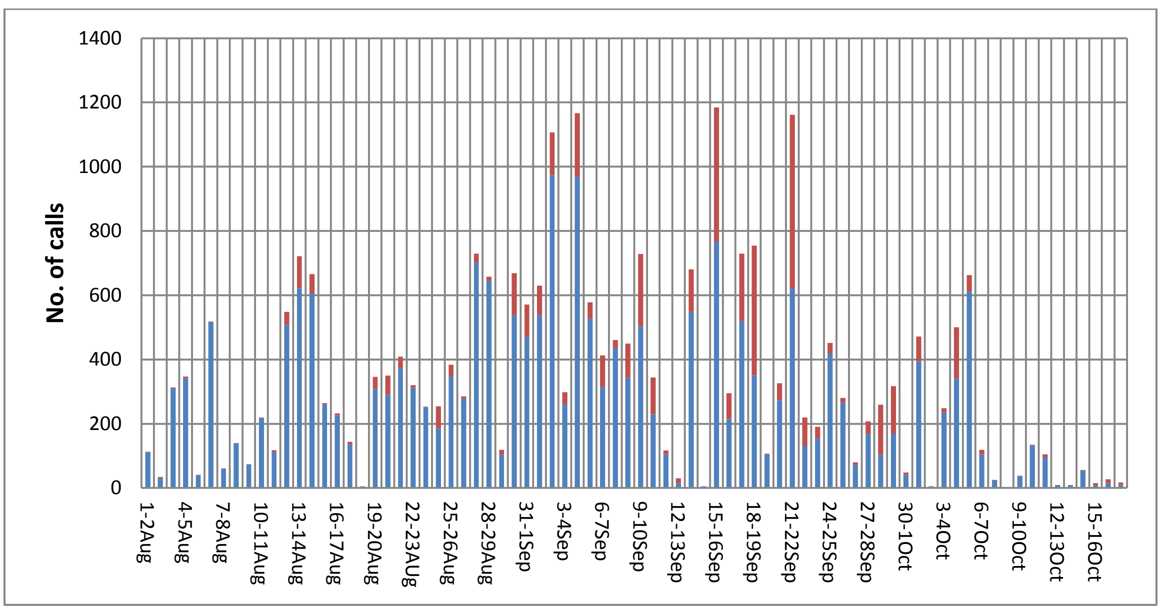

Figure 9. Nightly flight call activity at the Flatrock acoustic monitoring station in fall 2008. Blue section of bars indicates warbler & sparrow flight call totals; red section indicates thrush-type call totals.

The CVP-n station on the Cape Vincent Peninsula (53 km northwest of MRWP) operated concurrently with the Flatrock station for 46 nights (August 26-October 10), logging nearly 10,000 warbler and sparrow calls. Figure 10 shows the variation in nightly warbler and sparrow call totals for each station. While some nights

[18] The record continued through the night of November 15 but few calls were recorded after October 17.

appear to show related density changes, others clearly do not. Many nights showed greater calling at the Flatrock station than the CVP-n station. On the contrary, the night of September 28-29 showed much greater calling at the CVP-n station. This was a night when low cloud ceiling apparently inhibited migration over the Tug Hill Plateau but was sufficiently high in the lowlands to the north for substantial migration. Unlike the 14-night period compared in fall 2007 (Figure 5), there was no statistical correlation in the nightly flight call activity between these stations for the 47-night comparison period in fall 2008 ($p > 0.5$).

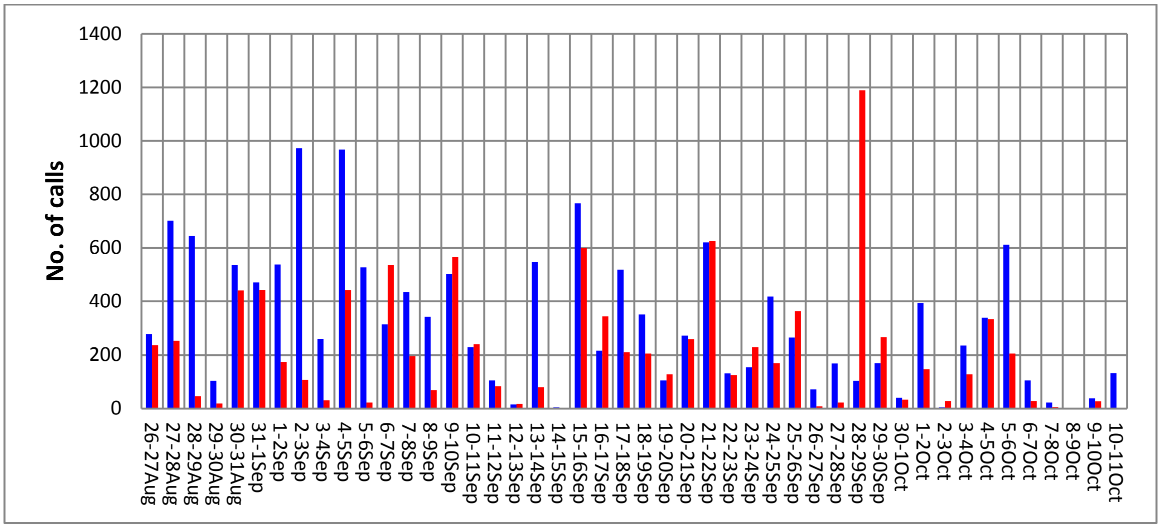

Figure 10. Comparative nightly warbler and sparrow flight call detections at the Flatrock and CVP-n acoustic stations in fall 2008. Blue bars represent calling from Flatrock and red bars represent calling from CVP-n.

Besides looking at numbers of warbler and sparrow flight calls, the mean nightly loudness of all warbler and sparrow calls was tallied at the Flatrock acoustic station for use as a potential index to flight altitude. Figure 11 shows relative loudness levels for nights that had more than 100 warbler and sparrow calls.

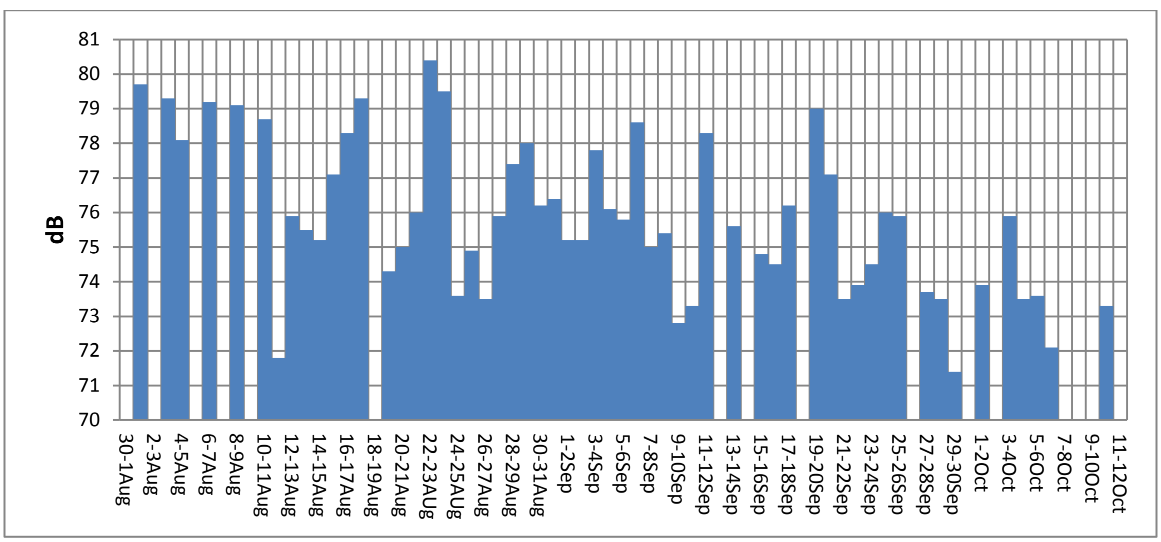

Figure 11. Mean relative loudness of warbler & sparrow calls at the Flatrock acoustic station in fall 2008 for nights when more than 100 calls were recorded.

A 6 dB difference in Figure 11 indicates that the mean call loudness was either twice or half as loud. For example, the mean call loudness on the night of September 9-10 was 72.8 dB. This was about half as loud as the 78.3 dB mean loudness on the night of September 11-12 and suggests that the mean flight altitude of vocal warblers and sparrows was lower on the night of September 11-12.

Figure 12 shows how the percentage of each species' calling at the Flatrock acoustic station during the fall 2008 period compared with that of concurrent monitoring at the CVP-n acoustic station in fall 2007 and 2008.

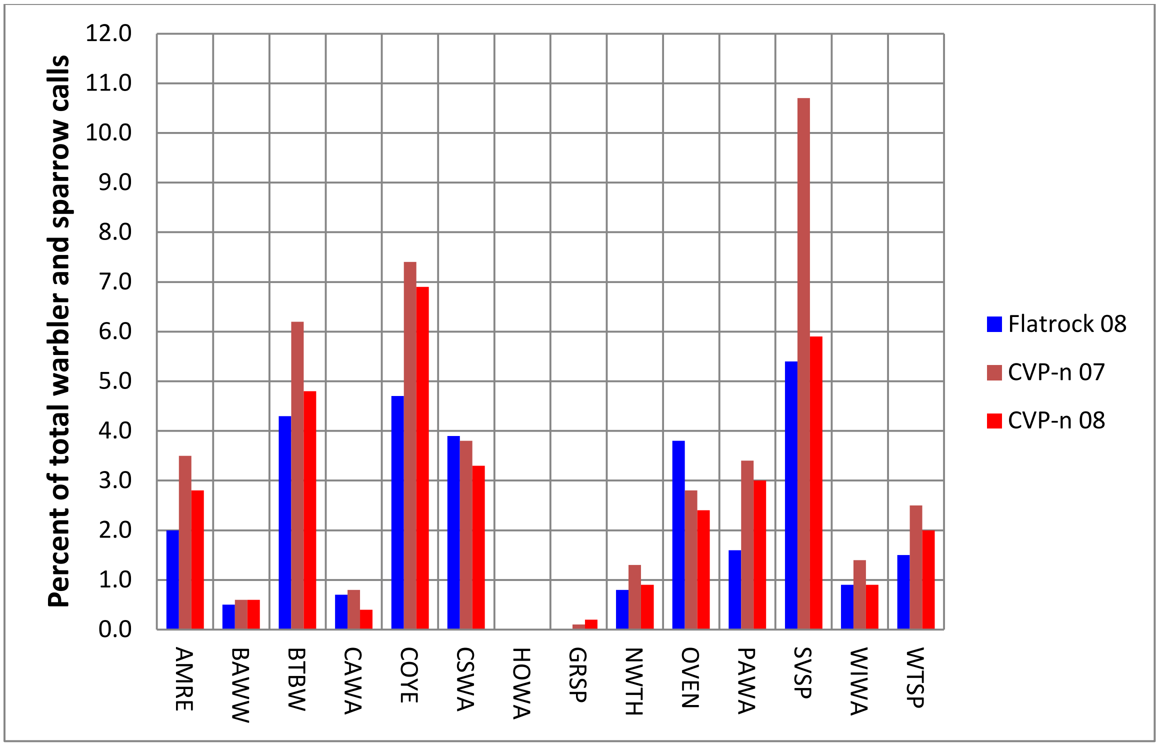

Figure 12. Species percentages of warbler and sparrow calling from the night of August 26-27 to October 6-7 2008 at the Flatrock and CVP-n acoustic stations. Blue bars represent calling from Flatrock, dull red bars represent calling from CVP-n in 2007, and bright red bars represent calling from CVP-n in 2008. See Figure 7 for 4-letter species codes. Three additional species included in this graph are GHSP = Grasshopper Sparrow; HOWA = Hooded Warbler; WTSP = White-throated Sparrow.

While no positive correlation was found in the nightly totals between the fall 2008 Flatrock and CVP-n acoustic stations (Figure 10), Figure 12 shows general good similarity in the proportions of the noted species. However, several inconguities stand out. The most notable is the larger percentage of Savannah Sparrow calls at CVP-n in fall 2007. The consistent 50 percent or greater increase in the proportion of Common Yellowthroat and Parula Warbler at CVP-n versus Flatrock also stands out. The only species where Flatrock had a notably higher proportion than CVP-n was Ovenbird. Less noticeable in Figure 10 is the higher percentage of Grasshopper Sparrow calls at CVP-n than Flatrock. The former had seven Grasshopper Sparrow flight calls while Flatrock had none.

For regional comparison, Figure 13 shows species proportion data from the Alfred station for the same time period illustrated in Figure 12 during fall 2007, 2008, and 2011.[19] Table 4 shows the numerical percentages of species calling illustrated in Figures 12 & 13.

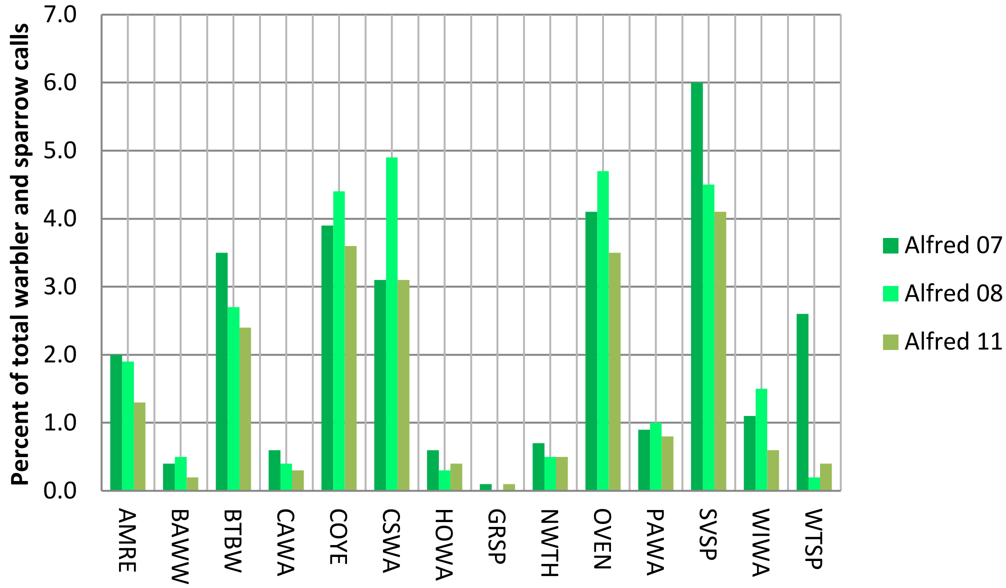

Figure 13. Species percentages of warbler and sparrow calling from the night of August 26-27 to October 6-7 2007, 2008 & 2011 at the Alfred station (8:30 p.m. -5:30 a.m.). Olive-green bars indicate data from 2011, lime-green bars indicated data from 2008, and grass-green bars indicated data from 2007. See Figure 7 & 12 for 4-letter species codes.

[19] Species analysis of acoustic data for the Alfred station in fall 2009 and 2010 is in progress as this report is being written.

Table 4. Species percentages of warbler and sparrow calling from the night of August 26-27 to October 6-7 2008 at New York acoustic monitoring stations. Total warbler and sparrow calling during the period = n. Total % is the percent of the noted species out of all warbler and sparrow calls recorded during the study period. See Figures 7 & 12 for 4-letter species codes.

	Flatrock 08	CVP-n 07	CVP-n 08	Alfred 07	Alfred 08	Alfred 11
AMRE	2.0	3.5	2.8	2.0	1.9	1.3
BAWW	0.5	0.6	0.6	0.4	0.5	0.2
BTBW	4.3	6.2	4.8	3.5	2.7	2.4
CAWA	0.7	0.8	0.4	0.6	0.4	0.3
COYE	4.7	7.4	6.9	3.9	4.4	3.6
CSWA	3.9	3.8	3.3	3.1	4.9	3.1
HOWA	0	0	0	0.6	0.3	0.4
GRSP	0.0	0.1	0.2	0.1	0	0.1
NWTH	0.8	1.3	0.9	0.7	0.5	0.5
OVEN	3.8	2.8	2.4	4.1	4.7	3.5
PAWA	1.6	3.4	3.0	0.9	1	0.8
SVSP	5.4	10.7	5.9	6.0	4.5	4.1
WIWA	0.9	1.4	0.9	1.1	1.5	0.6
WTSP	1.5	2.5	2.0	2.6	0.2	0.4
Total %	**30.1**	**44.5**	**34.1**	**29.6**	**27.5**	**21.3**
n =	***14558***	***8205***	***9605***	***8539***	***9212***	***12010***

The inter-year comparison of acoustic data from the Alfred station shows good correspondence between years. A notable variance occurred for Chestnut-sided Warbler in 2008 with nearly a five percent proportion compared to only around three percent in 2007 & 2011. Also note the higher proportions of Savannah Sparrow and White-throated Sparrow in 2007. These latter two species are common October migrants through New York and it appears there was an early sparrow migration in 2007 that bumped the proportions up relative to 2008 and 2011. Noticeably, the White-throated Sparrow proportion is higher at the northern New York stations than at Alfred in 2008 (Figures 12 & 13).[20]

Further comparison of the Alfred acoustic data with that from the northern New York sites suggests that the Black-and-white Warbler, Black-throated Blue Warbler, and Parula Warbler passed over the northern New York region in higher proportion (calling percentage higher by 50 percent or more) than over the Alfred station in west-central New York. The Hooded Warbler provides the most outstanding example of a species

[20] Presumably because the White-throated Sparrow migration was more advanced at the latitude of the northern New York acoustic stations, which is 130-150 km north of Alfred, New York.

that is a more common migrant over the Alfred station than the northern New York stations, based on nocturnal flight call monitoring. The CVP-n station did not have any Hooded Warbler detections and the Flatrock station only had five in the comparative fall 2008 study period. In the same time period of 2007, 2008, and 2011, the Alfred station had 30-50 Hooded Warbler calls each year. Although present and expanding in west-central New York over the past few decades, the current breeding range of the Hooded Warbler barely reaches the MRWP. Figure 14 shows the New York Breeding Bird Atlas map showing documented Hooded Warbler distribution during 2000-2005[21]:

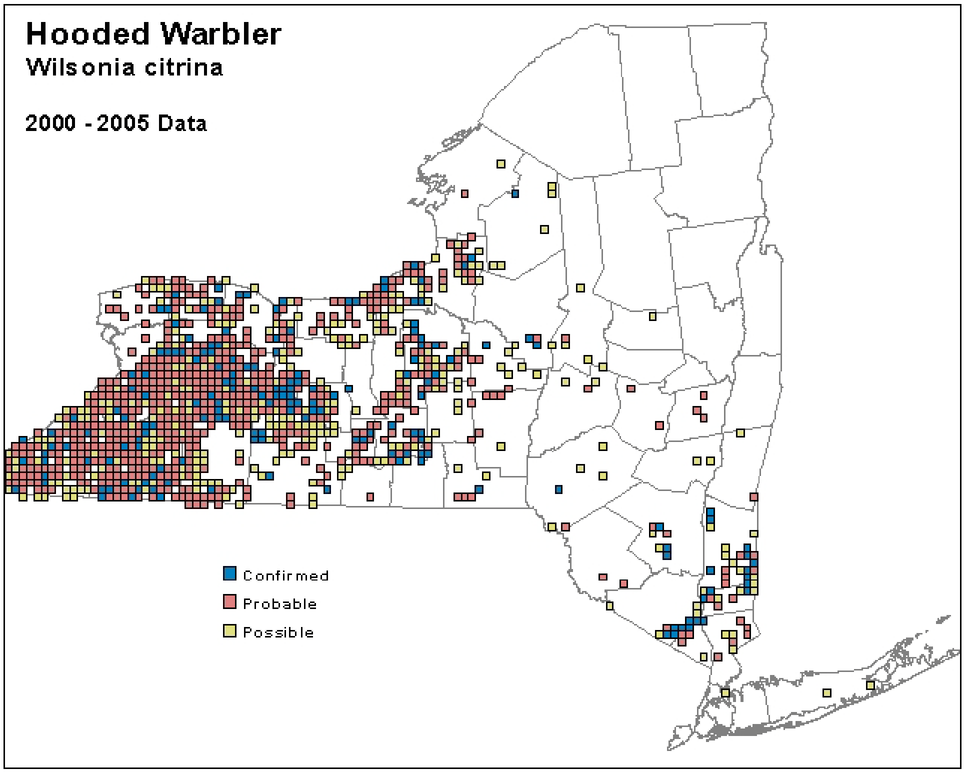

Figure 14. New York Breeding Bird Atlas Hooded Warbler distribution 2000-2005.

[21] http://www.dec.ny.gov/cfmx/extapps/bba/bbaMaps.cfm?bndcode=HOWA&year=2000

6.0 DISCUSSION

6.1 Avian acoustic monitoring as a technique for documenting species of potential collision risk

Surveys for the wind project documented 16 avian species via nocturnal flight calls that were not previously noted in the pre- or post-construction surveys for the wind project. Currently in New York, environmental impact statements for wind projects usually only address state and federal listed species in detail. Impacts for other species are typically addressed as a group, such as "songbirds". In the case of many species of common songbirds (e.g. Baltimore Oriole, Scarlet Tanager, Rose-breasted Grosbeak), these species are generally assumed to occupy a wind project (either as a breeder or in migration) and are at risk of collision for part of the year. In the case of the 16 new species documented via flight calls at MRWP, two are classified as "Threatened Species" in New York (Least Bittern and Upland Sandpiper). These secretive species are in fact much easier to document while in nocturnal migration than diurnally during their migration periods. However, it is questionable whether simply documenting the presence of these species within a wind project during migration would be of utility to New York wildlife regulators. This is because at present these species are presumed to potentially occur in small numbers in migration over many regions of New York, so their documentation during migration periods within the wind projects would not be unexpected.[22]

6.2 Avian acoustic monitoring as a technique for delineating the relative risk of night migrant collisions

The acoustic data comparison between the MRWP station, the "array" stations, and the Alfred acoustic station suggests that some species have denser migration over one region or the other. If the species composition of fatalities is related to the activity of species in the airspace of a wind project, acoustic data indicating different migration activity levels may be reflected in fatality data. As a heuristic example, based on flight call data from this study (Figure 12; Table 4), Hooded Warbler would currently be a much more likely collision fatality at wind projects in west-central New York than in other areas of the state. This is strongly supported by data from the New York Breeding Bird Atlas (Figure 14).

When it comes to common songbird species that breed in Canada and migrate all across New York, one might presume that proportionate flight call activity differences that occur consistently from one year to the next would translate to wind farm collision risk. For example, the 50% lower proportion of Black-throated Blue Warbler flight calls documented over multiple years at the Alfred station relative to the northern New York acoustic stations (Figures 12 & 13; Table 4). This suggests that Black-throated Blue Warbler fatalities would occur at wind projects in both regions, but may be more common relative to other species monitored by flight calls in northern New York (at least for the region of the MRWP and Cape Vincent). However,

[22] Evans and Mellinger (1999) presented acoustic data showing Upland Sandpiper flight calling detected from a transect of acoustic monitoring stations across New York. Data in their report suggests that in the early 1990s the species was more common as a fall migrant in western and central New York than eastern New York.

whether a wind turbine in northern New York would incur more Black-throated Blue Warbler fatalities on average than one near Alfred would be dependent on the volume of migration in each region. In other words, a higher proportion detected acoustically wouldn't be expected to translate into a higher fatality rate unless the volume of migration is the same or higher in this case.

For example, there are similar (3.8 vs.3.9) proportions of Chestnut-sided Warbler flight calling to total calls in the Flatrock 2008 and CVP-n 2007 data illustrated in Fig 12 and Table 4. However, Flatrock had 14,558 total warbler and sparrow calls while the CVP-n station had 8,205, a 44 percent difference. That translates into 568 Chestnut-sided Warbler flight calls detected at Flatrock versus only 312 at the CVP-n station. The difference in these raw numbers suggests differing collision risk, as opposed to the near equivalent risk suggested by proportional data. However, recall the caveat discussed in the methods section about the impact of ambient environmental sound on the detection rate of avian night flight calls. Calls of relatively low loudness, arising from near the edge of the zone of microphone sensitivity, are the first to be masked by increasing environmental noise. In fact, a station with only 312 Chestnut-sided Warbler flight calls detected might in fact represent the same rate of passage below WTG height as a station with 568 Chestnut-sided Warbler flight calls detected – it may just have had substantially greater environmental noise that masked detection of such weaker calls.

One way to compensate, and connect ratio data with raw flight call numbers, is to measure the relative background noise level between acoustic stations. If one documents that background noise is about the same in the frequency band of interest between two similar stations, then differences in actual flight call rates are more directly comparable. If there is a substantial difference in background noise, then one can at least anticipate calling differences between stations (e.g., Larkin et al. 2002). Furthermore, if stations are calibrated to have similar sensitivity, then it is possible to screen out calls that fall below some set level of loudness. This study only intended to analyze data from one acoustic station, so background noise wasn't measured relative to the other stations. Data from these additional stations turned out playing a bigger part of this study after comparative migration activity data from fall 2007 and spring 2008 were lost due to audio interference issues.

Evans & Mellinger (1999) and Evans & Rosenberg (2000) reported broad front flight call activity gradients from an east-west running transect of seven acoustic stations across a 300 km breath of New York (w/stations roughly 30-80 km apart). These studies indicated that, for some species, more proximal acoustic stations tend to have more closely related flight call activity patterns. This phenomenon is also indicated by strong correlation between flight call activity patterns within the "array" stations in northern New York. However, there is a case in this array data when species patterns do not appear to follow this pattern. The relatively high proportion of Common Yellowthroat flight calls (> 50 percent higher) at the CVP-n site in fall 2007 stands out as unrelated to two proximal acoustic stations, one within 10 km. The proportion of Common Yellowthroat calls was similarly high at CVP-n in fall 2008, suggesting this pattern may be an annual characteristic over this landscape. Perhaps the varied terrain amidst these array acoustic stations (peninsula, island, and shoreline) imparted this unusual species concentration. If this is true, Common Yellowthroat, might be a relatively more common fatality at the proposed Saint Lawrence Wind Project on the Cape Vincent Peninsula (location of CVP-n station) than at the Wolfe Island Wind Project or the MRWP, both of which had substantially lower proportions of Common Yellowthroat calling.

Currently, it is unknown how calling rate relates to the number of birds passing and how it might relate to the inherent collision risk for wind turbine generator (WTG) fatalities. It cannot be assumed that species call at the same rate. For example, detection of 100 Ovenbird flight calls in a night may not represent the same number of birds as 100 Northern Waterthrush calls over the same duration of time. It also can't be assumed that the number passing increases linearly with calling rate. However, the data presented in this report suggests that there are inherent, signature, calling patterns for species at any location in a region. The evidence in New York suggests that for some species these patterns may be fairly uniform across a broad (i.e., 100 km) swath of landscape, but for others there apparently can be substantial changes within as little as 10 km. Therefore, in making flight call comparisons between sites, one must consider the raw numbers with respect to comparative ambient noise as well as the species proportion data. Furthermore one must consider the distribution of calling in the period of study. For the acoustic data reported in this study, regular flights occurred throughout the migration study periods. In past years however, stalled out tropical systems and other weather anomalies have formed blocking systems that curtail migration for several weeks. Such dynamics need to be considered when making inter-year comparisons, as odd seasonal weather patterns may lead to odd species detection patterns. Also, as noted in the methods section, some species have increased calling rates in the period before dawn. One must be careful that such calling doesn't skew comparison. Finally, in characterizing species abundance patterns between regions, operating multiple stations in each region simultaneously is essential. Confidence in patterns is bolstered when multiple stations show similar results.

6.3 The challenge of correlating avian acoustic data with WTG fatality data

From the standpoint of verifying the utility of acoustic monitoring for predicting avian fatalities, the weak link in this study was the paucity of avian night migrant fatalities documented in the MRWP fatality surveys. Undoubtedly, there were many more fatalities at the MRWP in 2007 and 2008. Once a species is documented as a fatality, its estimated actual fatalities can be assessed by factoring in scavenging and surveyor efficiency information. For example, in the Curry & Kerlinger fatality report covering the 2008 season, two Black-throated Blue Warblers were documented and it was estimated that the project killed 20 that year.[23] However, in the Curry & Kerlinger report covering the more intensive 2006 fatality survey, annual estimates for Black-throated Blue Warbler fatalities at only 120 WTGs ranged as high as 68. This depended on whether the estimate was constructed with information from fatalities at WTGs searched daily, every three days, or once a week.[24]

There is clearly uncertainty with the current fatality data at MRWP, particularly in relation to specific species. The scope of fatality studies at MRWP and other projects in New York has been reduced based on statistical analysis and in doing so may be less able to inform us about species specific effects.[25] For example if, as indicated by the Curry & Kerlinger fatality studies at MRWP, only one in ten (or more) Black-throated Blue Warblers are found, there is a good chance that many avian species are regularly impacted at MRWP that weren't documented during the three years of fatality studies. This species information falls through the statistical cracks of the current fatality survey protocol in New York due to the low sampling rate.

With respect to the species of focus in the warbler and sparrow acoustic data, only Black-throated Blue warbler was documented to be a fatality during the acoustic study period (two in fall 2008). This was one of the common callers in the acoustic study and composed over four percent of the calls from late August through early October 2008. But there were three other vocal night migrant songbirds that also composed over four percent of the warbler and sparrow calling (Common Yellowthroat, Ovenbird, and Savannah Sparrow), and none of these species were documented as fatalities. There are a number of factors that may influence this. One is that perhaps the Black-throated Blue Warblers were all males. The sex of bird carcasses, a standard fatality study metric, was not provided in the Curry & Kerlinger reports. The male Black-throated Blue Warbler would certainly be one of the most visible fall warbler fatalities, the fact that at least ten Black-throated Blue Warblers were documented over the three years of fatality study at MRWP may reflect the fact that this species is easier for surveyors to notice than the other three species.

The documentation of a Prairie Warbler fatality at MRWP in 2007 apparently illustrates that no matter how uncommon a species may be within a wind project, risk of collision fatality still exists. The MRWP is near the northern edge of the range for Prairie Warbler, with just a few small populations known to the north – see New York Breeding Bird Atlas range map for Prairie Warbler below:

http://www.dec.ny.gov/cfmx/extapps/bba/bbaMaps.cfm?bndcode=PRAW&order=2&year=2000&comp=0

[23] Jain et al., 2009.
[24] Jain et al. 2007. See Table 20.
[25] Based on an unpublished statistical analysis by J. Gibbs SUNY-ESF Syracuse, New York (March, 28 2007): *Assessment of Trade-offs in Precision Relative to Sampling Frequency and Site Number of Sampling Bat and Bird "In Fall" at the Maple Ridge Wind Farm, Tug Hill, New York.*

The fact that the regionally rare night migrant, Prairie Warbler, was documented as a fatality at MRWP while a common night migrant such as Common Yellowthroat has not been documented may simply be due to chance amidst the very small sample size of songbird fatality recoveries. [26] In any case, the songbird fatality record produced by the MRWP fatality studies does not appear to reflect the species composition of avian night migration through the wind project based on a robust sample of night flight call activity.

To determine if there is a correlation between avian acoustic data and songbird fatalities at wind projects, two conditions may be necessary. First, study sites need to have relatively large, low altitude, passage of songbirds. Figure 17 shows radar passage rates below WTG height at 19 proposed or constructed wind projects in New York.[27] Though these data are primarily based on only one season of data, the suggestion so far is that passage rate below WTG height varies by nearly an order of magnitude in New York depending on location. The purple circle in Figure 17 shows the 12 targets per kilometer per hour mean fall migration passage rate below WTG height (<125 m) documented at the MRWP by Alaska Biological Research Inc. in 2004. Note that this is one of the lowest fall passage rates below WTG height of all the 19 publically available radar studies currently presented on the New York Department of Environmental Conservation website. Thirteen wind projects had higher passage rates below WTG height and four projects had passage rates approximately four times higher. Theoretically, these latter sites might have songbird fatality rates four times higher than that documented at MRWP. However, as noted, these are only single-season radar data and multiple years of radar study are necessary to affirm a characteristic passage rate for a specific location relative to another. It is undetermined how the variables of population size, migration routes, and weather dynamics may have contributed to these data. Therefore, one would want to conduct future studies at sites that theoretically have, or are demonstrated to have, relatively high songbird collision fatalities.

The second condition necessary for future studies looking to correlate avian acoustic data with wind project fatality data is that studies need to have robust survey protocols. While statistical evidence may suggest that once a week surveys are sufficient for estimating numbers of fatalities at a wind project, such a protocol reduces the species richness of fatality datasets. Rigorous daily surveys (e.g., 24 x 60 m transects, five m apart) of a large number of well-manicured WTG study plots are necessary to maximize the number and species richness of songbird carcasses recovered. This would provide greater nightly resolution in fatality data for use in understanding impacts of specific migration and weather events.

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[26] Two Common Yellowthroat fatalities have been documented at the Cohocton Wind Project near Naples, NY, so the species is not immune from WTG collision.

[27] http://www.dec.ny.gov/docs/wildlife_pdf/radarwind.pdf (accessed December 26, 2011)

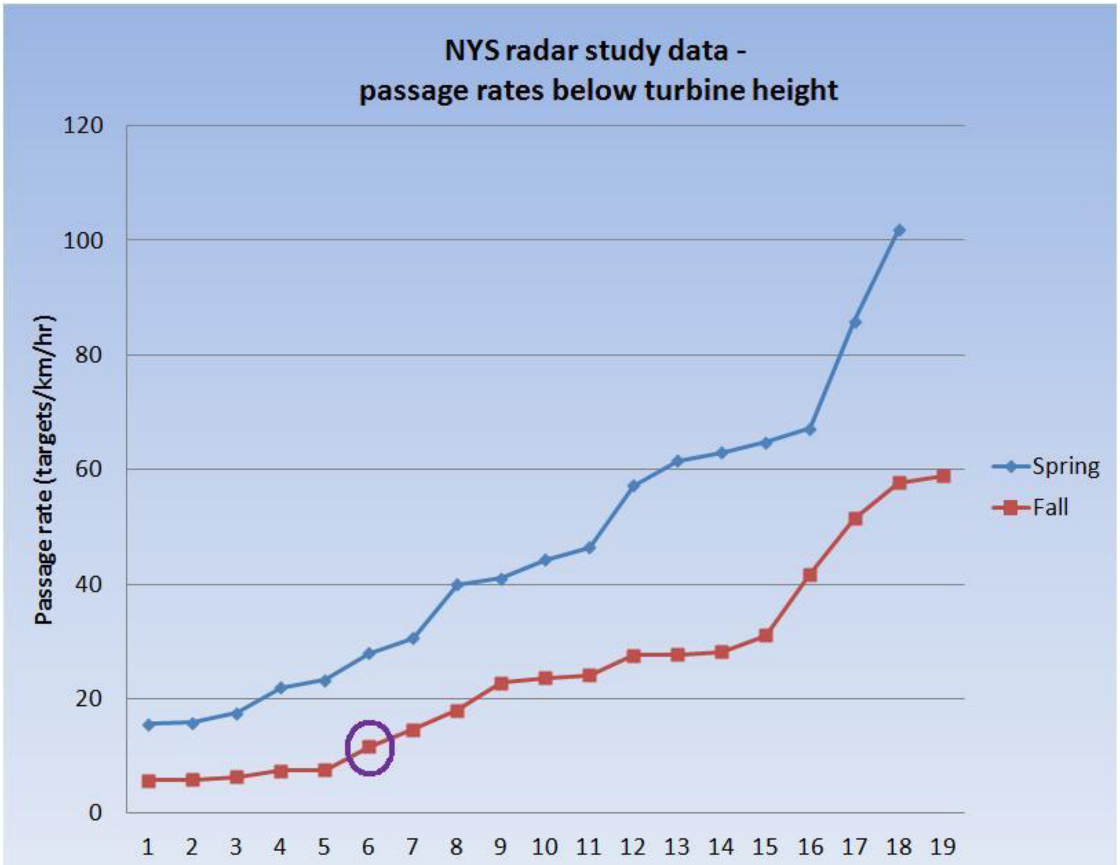

Figure 15. Comparative spring and fall mean passage rates (targets per kilometer per hour) below WTG height (<125 m) determined by 19 marine radar studies in New York. Purple circle shows the 2004 fall migration period (August 5 – October 3) mean passage rate determined by Alaska Biological Research Inc. at the MRWP.

While a single acoustic station was used in this study, at least four acoustic monitoring stations located in transects across the wind project area would be ideal for a project the size of the MRWP. Four stations would greatly augment the size of the acoustic dataset, especially in spring, and serve better for tracking broad front variations in migration activity.

6.4 Artificial light, low cloud, and other variables affecting flight calling rates

The combination of artificial light and low cloud ceiling can cause disorientation in night migrating birds, especially songbirds, and greatly augment their calling rate. Evans et al. (2007) document that as little as a 250W whitish light shining skyward can dramatically increase flight call rate on low cloud ceiling nights. In fact, this phenomenon was noted by W. Evans on numerous evenings in fall 2007 & 2008 at the MRWP headquarters on Eagle Factory Rd. The MRWP headquarters has an American flag that is illuminated with a ground-based light aimed upward toward the flag. Unfortunately, much of the light beam escapes into the atmosphere and during migration this vagrant light induces substantial bird aggregation events over and around the MRWP headquarters on low cloud ceiling migration nights. Increased avian fatalities due to this MRWP headquarters light condition might have been documented if the proximal WTG north of the building had been included in the fatality study. It is worth noting that around 500 Blackpoll Warblers, a night migrating songbird that breeds largely in northern Canada and winters in South America, were recent fatalities at a brightly lit compound associated with the Ned Power wind project in northern West Virginia.[28]

With regard to the acoustic stations included in this study, the monitoring sites were not associated with any bright artificial light sources, but differences in artificial light existed between some study sites. The spring 2007 MRWP had no artificial light in close proximity and the only close residence with night lighting was a kilometer away. The Alfred station was similarly dark. The CVP-n site had no artificial light associated with the barn where it was located. The WI-w and WI-s stations were farmland residential sites with no light in close proximity but residential night lighting within 150 meters. The CVP-ns site was along the residential shoreline of the Saint Lawrence River, 8 km northeast of the village of Cape Vincent, New York. The Flatrock station that operated in fall 2007 & 2008 had the most artificial light of any station in this study. This station was located adjacent to the Flatrock Inn, a small recreational vehicle resort atop "Tug Hill", which had a single mercury vapor street light operating all night. There were also several incandescent porch lights as well as beer sign lights that emanate from windows inside the small restaurant and bar associated with the Inn. The porch lights were typically turned off after operational hours.
Based on the higher than typical flight call totals documented at the Flatrock station during fall 2007 & 2008, and the regular spikes in flight call activity relative to the CVP-n station, there may have been some impact on flight call rate from the artificial light associated with the nearby Flatrock Inn. However, no major calling events typical of light-induced bird disorientation were documented. While artificial light in conjunction with low cloud ceiling is the only documented environmental factor affecting flight call rate, there may be other sources. For example, adjacent to the Flatrock station there is a large pond that depending on wind conditions reflects starlight, a well-documented navigation cue for night migrating birds. Perhaps this dynamic elicited extra calling from birds in night migration over the Flatrock station.

[28] http://www.abcbirds.org/newsandreports/releases/111028.html (accessed December 12, 2011)

7.0 CONCLUSIONS

Acoustic monitoring of avian flight calls using automated equipment and semi-automated analysis is a relatively inexpensive methodology providing unique and often voluminous information on the species active in the airspace of industrial wind energy projects. While there are a number of variables and unknowns involved with interpreting avian night migrant vocalization data, this is typical with every nocturnal migration monitoring method. The fact is that acoustic monitoring is the only economical means we have for studying species movements at night, a time when wind turbine generators are less visible and theoretically present more of a collision hazard. What stands out amidst the unknowns with acoustic monitoring are the remarkably consistent temporal and geographic calling patterns that occur. Such data may reflect inherent fatality patterns of night migrating songbirds and other bird species at industrial wind energy projects. This may be validated over time as more wind project fatality studies are carried out in regions documented to have differing migration patterns. It may be acknowledged sooner if avian acoustic studies are carried out in conjunction with robust fatality studies at wind projects that have relatively high fatality rates. Unfortunately, this was not the case at the MRWP in fall 2008. It stands out that over 20,000 warbler and sparrow nocturnal flight calls were documented at the Flatrock station in the fall 2008 monitoring period (August 1 – October 17) but only two individuals of the species represented were documented in the MRWP fatality study during that time.

The extent to which acoustic monitoring is employed for pre- and post-construction monitoring at wind energy projects will largely be determined by state and federal wildlife regulators. Their perception of how significant the impacts from wind energy are to night migrating birds depends on robust and accurate fatality studies. However, the current trend is to reduce the scope of fatality studies, relying more heavily on statistical corrections to estimate actual fatalities. Based on current fatality survey protocols and the data they have produced, it appears unknown whether 3,000 industrial wind turbines in New York would incur 250 or 2,500 Black-throated Blue Warbler fatalities annually, and there is a similar order of magnitude discrepancy in our understanding of impacts to other night migrating birds. It is also likely that many species involved in WTG collisions in New York are going undetected.

Acoustic monitoring of avian nocturnal migration has potential to fill some of this void of knowledge, and current research is advancing our knowledge.[29] Development of efficient machines to harness wind energy takes time, and so do the monitoring methodologies that seek to understand and minimize wind energy's avian impacts.

[29] Avian flight call data from six sites across New York are available via http://www. oldbird.org

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